Golden Eagles in a Perilous Landscape

Contract #: 500-97-036
Contractor: University of California at Santa Cruz (Predatory Bird Research Group)
Contract Amount: $675,121 and $45,850
Contractor Project Manager: Grainger Hunt
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The Issue

In 1988, a California Energy Commission study[1] reported that some birds in the Altamont Pass Wind Resource Area (APWRA) were being killed by wind turbine blade strikes. Since that time, government, private, and industry researchers have conducted numerous studies on the subject. A common finding among those studies has been that raptors (birds of prey) are abundant in the APWRA and experiencing high levels of fatalities due to collisions with turbine blades.

Golden Eagle at APWRA by Daniel Driscoll

Golden eagles are one species of particular concern at the APWRA. Although not federally or state-listed as a threatened or endangered species, golden eagles are protected by the Bald and Golden Eagle Protection Act[2] and the Migratory Bird Treaty Act of 1918,[3] both of which prohibit the killing of these birds. Researchers estimate that wind turbines in the APWRA kill 40–60 subadult and adult golden eagles each year, on average—in violation of both acts. In addition, because golden eagles are slow to mature and reproduce, there has been a concern that fatalities from wind turbine blade strikes in the APWRA could affect the ability of adult and subadult golden eagles in the area to reproduce sufficiently to maintain a viable population level.

Finding a remedy to these fatalities is crucial. California wind turbines contribute 3 billion kilowatthours of electricity every year to the State's grid, and Renewable Portfolio Standards (RPS) require the contribution to the State's generation capacity from renewable energy sources to increase from current levels of ~10% to 20% by 2010. The APWRA could play a vital role in meeting that target. While the ~5000 turbines at the APWRA consist of older, outdated turbine

[1] Anderson, R. L., and J. A. Estep. 1988. *Wind Energy Development in California: Impact, Mitigation, Monitoring, and Planning*. California Energy Commission. Sacramento, California.
[2] 16 U.S.C. § 668.
[3] 16 U.S.C. §§ 703-711.

designs that produce much lower kilowatts per turbine than newer, more efficient designs, plans to replace these with modern wind turbines (repowering) have been implemented on a very limited basis, in part, because the avian issues have not been resolved.

Many stakeholders predict that repowering the APWRA with a fewer number of larger turbines would reduce avian fatalities at the site; however, there is no scientific evidence to support this hypothesis. At the time of these studies, Alameda County (where much of APWRA is located) would not approve additional permit applications to increase the APWRA's electrical production of 583 megawatts (MW) until research demonstrates significant progress toward the bird fatality issue.

Project Description

The Predatory Bird Research Group (PBRG) at the University of California at Santa Cruz had been conducting a three-year study (1994–1997) of golden eagle mortality from wind turbines at the APWRA. This work, funded by the National Renewable Energy Laboratory (NREL), used aerial tracking of radio-tagged eagles to address the question of whether eagle deaths resulting from wind turbine strikes were affecting the local population, whose density was determined during that study to be among the highest known in the world. Two population models concluded that the population was declining during the period of study and turbine blade-related mortality was identified as a significant contribution to that decline. However, the two models produced two, divergent scenarios of the rate of population decline, one much more severe than the other.

The PIER Environmental Area funded a research project with PBRG in 1998 to build upon the earlier NREL study to determine which of the population models most accurately described the trend of the golden eagle population and to determine if repowering with newer, larger turbines would reduce the existing levels of eagle mortality. However, when it became apparent that wind turbine repowering in the area was going to be delayed beyond this project's time frame, the second focus shifted to tracking golden eagles in the area, to identify which factors may contribute to blade-strike mortality.

To do so, the PBRG continued to monitor the 179 radio-tagged eagles from the previous NREL study and captured and tagged additional eagles from 1998 to 2000, to increase the size of the study group to 257. Researchers also conducted an annual nesting survey of 60–70 pairs within about 30 kilometers (19 miles) of the APWRA. In addition, they applied a more precise model of estimating population trend.

Results of this study indicated that the golden eagle population is experiencing no annual change in population size; however, the statistical variance in the estimate showed no conclusive evidence as to whether the population is in fact increasing or decreasing in size. Results also suggested that most of the eagles killed in APWRA derive from the local population. The researchers cautioned that the high incidence of turbine-caused mortality to nonbreeding adults and subadults may be preventing the maintenance of an adequate reserve of nonbreeding adults necessary to a buffer and maintain healthy populations. They therefore recommended follow-up surveys be conducted every two or three years to monitor occupancy of nesting territories, a technique that provides an indication of population health.

The PIER Environmental Area funded further research with Hunt and Hunt, the researchers of the PBRG report, in 2005, to conduct a follow-up survey to detect if golden eagle territories in the vicinity of the APWRA remained occupied. As a further indication of population health, the research also noted the age-class of each nest-occupier, because an increase in the proportion of younger, subadult eagles would suggest an unhealthy scarcity of nonbreeding adults. A lack of appropriate nonbreeding adults would suggest that the fatalities of this age-class from turbine strikes were impacting the local population.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous public benefits and meets the following PIER program objectives:

- **Provide environmentally sound electricity.** The information gathered by tracking golden eagles at the APWRA helps researchers better understand how turbine operation in the APWRA affects one of the largest golden eagle populations in North America. The information gained can be applied to both repowering the APWRA in an environmentally responsible manner and to avoid replicating this environmental problem during future decisions regarding placement of wind power facilities in other parts of the State.
- **Provide reliable electricity.** California needs to ensure that wind energy provides a significant contribution to renewable energy supplies to the grid. Currently, impacts to golden eagles and other raptors are a concern in new and repowered developments. Addressing the impacts to golden eagles and other raptors will help alleviate the concern by many stakeholders that the operation of wind turbines, both in the APWRA and in other wind resource areas around the state, are negatively impacting birds. As a result, California could benefit from a greater supply of clean, renewable electricity generated by wind turbines.

Results[4]

July 2002 (Report P500-02-043F)

In the seven years that the PBRG tracked golden eagles at APWRA for NREL and the Energy Commission, researchers attributed 42 of 100 golden eagle deaths to wind turbine blade strikes, although the number may have been higher, because some of the transmitters were destroyed by blade strikes (25 percent of cases). Twelve more fatalities were attributed to electrocution from electrical lines. Of the 42 eagles struck by turbine blades, five were first found alive but flightless due to injuries and away from the turbines, indicating that without the use of radio telemetry, these causalities may have gone unnoticed. Vehicle strikes and poisoning brought human-related fatalities to at least 68 percent of the total.

The magnitude of golden eagle fatalities found in this study reaffirm earlier studies by Orloff and Flannery (and reports by maintenance personnel who incidentally found dead eagles while servicing turbines) that a conservative estimate of golden eagle fatalities at the APWRA is about 40 per year. Results of the PBRG study showed that eagles killed were primarily from the local resident population, whose density was determined to be among the highest known in the world.

Turbine-caused fatality was highest for subadults and nonbreeding adults, the latter also called *floaters.* Researchers attributed this to the small home range that breeding adults have centered

[4] All results discussed here are drawn from this project's final reports.

around their nest sites, almost all of which were not in the APWRA area proper. Breeding adults with nesting territories that overlapped the APWRA were killed by turbine collisions. The low fatality among juveniles was attributed to the fact that this age class has a lesser tendency to hunt live prey, which led them to believe eagles tend to be struck while hunting.

Causes of Death Among 100 Radio-Tagged Golden Eagles in APWRA

Mortality Agent	Juveniles (17 fatalities) (%)	Subadults (49 fatalities) (%)	Floaters (22 fatalities) (%)	Breeders (12 fatalities) (%)	Total Fatalities
Turbine Blade Strike	5.9	63.2	36.4	16.7	42
Electrocution	22.5	10.2	13.6	-	12
Fledging Mishap	35.3	-	-	-	6
Hit by Car	-	6.1	4.5	-	4
Wire Strike	5.9	4.1	4.5	-	4
Eagle	-	-	9.1	16.7	4
Lead Poisoning	-	4.1	-	8.3	3
Botulism	-	-	-	8.3	1
Brodifacoum Poisoning	-	-	-	8.3	1
Shot	-	-	4.5	-	1
Hit by Train	5.9	-	-	-	1
Unknown	23.5	12.2	27.3	41.7	21

Source: California Energy Commission. 2002. *Golden Eagles in a Perilous Landscape.* p. 30.

The difference in fatalities among age class is important because a healthy population of eagles requires an adequate number of floaters to buffer the breeding segment of the population against decline. As territories become available, floaters fill the void to keep the population productive. Nesting territories occupied by sub-adults are an indication that there is not a sufficient supply of floaters to fill this niche.

Taking these population parameters into consideration, the researchers selected an age-base population model. The model suggested that the local population is at equilibrium, but failing to maintain a contingent of non-breeding adults necessary to buffer the population against population declines, and a contingency potentially threatened by a high proportion of fatalities caused by wind operations. The researchers cautioned that any decrease in survival or reproduction may lead to unacceptable losses, and that turbine-related deaths combined with other human-related fatalities may cumulatively be detrimental. To protect against unacceptable declines, the researches needed to better understand whether the breeding sector was being supplemented by local or immigrant breeders and whether nest occupation was accomplished by

mature adults rather than sub-adults. They surmised that this could be better understood by conducting follow-up surveys every two or three years to determine if breeding territories remained occupied by breeding adults.

Researchers speculated that increases in blade-strike mortality were associated primarily with: (1) closeness between wind turbines, (2) closeness of the turbine blade to the ground, and (3) the prevalence of ground squirrels in an area. Type-13 wind turbine configurations were particularly implicated, because of the close spacing between these types of turbines, and because of the shortness of their towers, which puts their blade tip closer to the ground than 95 percent of all the other turbines in the APWRA.[5] Golden eagles glide close to the ground when hunting, which may place them in the path of these blades.

Researchers suggested that golden eagle safety could be improved by replacing the Type-13 wind turbines with a lesser number of larger, because the blades of the larger turbines are higher off the ground, and the towers would be more widely spaced. They also recommended ground squirrel control be employed to reduce the attractiveness of the area to eagles.

June 2006 (Report 500-2006-056)
The purposes of this follow-up effort was to determine whether the local population of golden eagles was maintaining a healthy situation of nest occupation by breeding adults and to continue to investigate whether turbine-caused fatalities were preventing the maintenance of adequate reserves of nonbreeding adults (floaters). A 2005 sample of 58 territories previously sampled in 2000 revealed that these sites were still occupied and that no upward trend in subadult occupation was apparent. Therefore, the population studied seems to have a sufficient source of non-breeding floaters to replace annual attrition of adult breeders.

The researchers concluded that the population of golden eagles in the vicinity of the APWRA remains intact. However, they cautioned that the impact of continued eagle fatalities from turbine strikes is not benign because the number of eagles produced cannot compensate for the number killed. They estimated that 167 breeding pairs are required to sustain 50 turbine-caused fatalities per year and the continued pressure on the population from urban sprawl and other human-related fatality sources (e.g., vehicle collisions, poisoning, and electrocution) will raise the number of eagle pairs required to sustain the number of turbine-caused fatality, even if the latter remains constant.

The researchers recommend actions be taken to secure habitat necessary to maintain breeding territories and to reduce the attraction of eagle use in the APWRA proper. They also recommend that eagle nest territory occupancy continues to be monitored every five years to detect early warning signs of population decline.

[5] Fifty-six percent of the wind turbines at the APWRA use a Type-13 configuration.

Final Reports
The final report on the results of this work are entitled:

Golden Eagles in a Perilous Landscape: Predicting the Effects of Mitigation for Wind Turbine Blade-Strike Mortality. (P500-02-043F. July 2002.) It can be downloaded from www.energy.ca.gov/reports/2002-11-04_500-02-043F.PDF.

The Trend of Golden Eagle Territory Occupancy in the Vicinity of the Altamont Pass Wind Resource Area: 2005. (P500-2006-056). It can be downloaded from www.energy.ca.gov/pier/final_project_reports/CEC-500-2006-056.html.

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